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NATURAL RESOURCES CONSERVATION SERVICE

Watershed Science Institute

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An Overview of Stormwater Management in the Portland, Oregon Metro Area

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Figure 1: Portland, Oregon.

Introduction

Portland, Oregon is well known for its progressive attitudes towards community planning, mass transit, and an urban fabric that supports a desirable quality of life. The Portland area (Figure 1) attempts to balance the conservation of natural resources with the demands of an expanding population base. Recent rapid growth has put this attempt to the test, so in April, 1997 a diverse group of NRCS and partners from Massachusetts, Mississippi, Vermont, Washington and Wisconsin met in Portland to learn about urban conservation initiatives. The visit was hosted by Portland Metro and its constituent communities. Portland Metro is a regional government with a national reputation in the planning of its urban watersheds, and in its management for urban growth. Nontraditional techniques for stormwater and riparian area management are also common.

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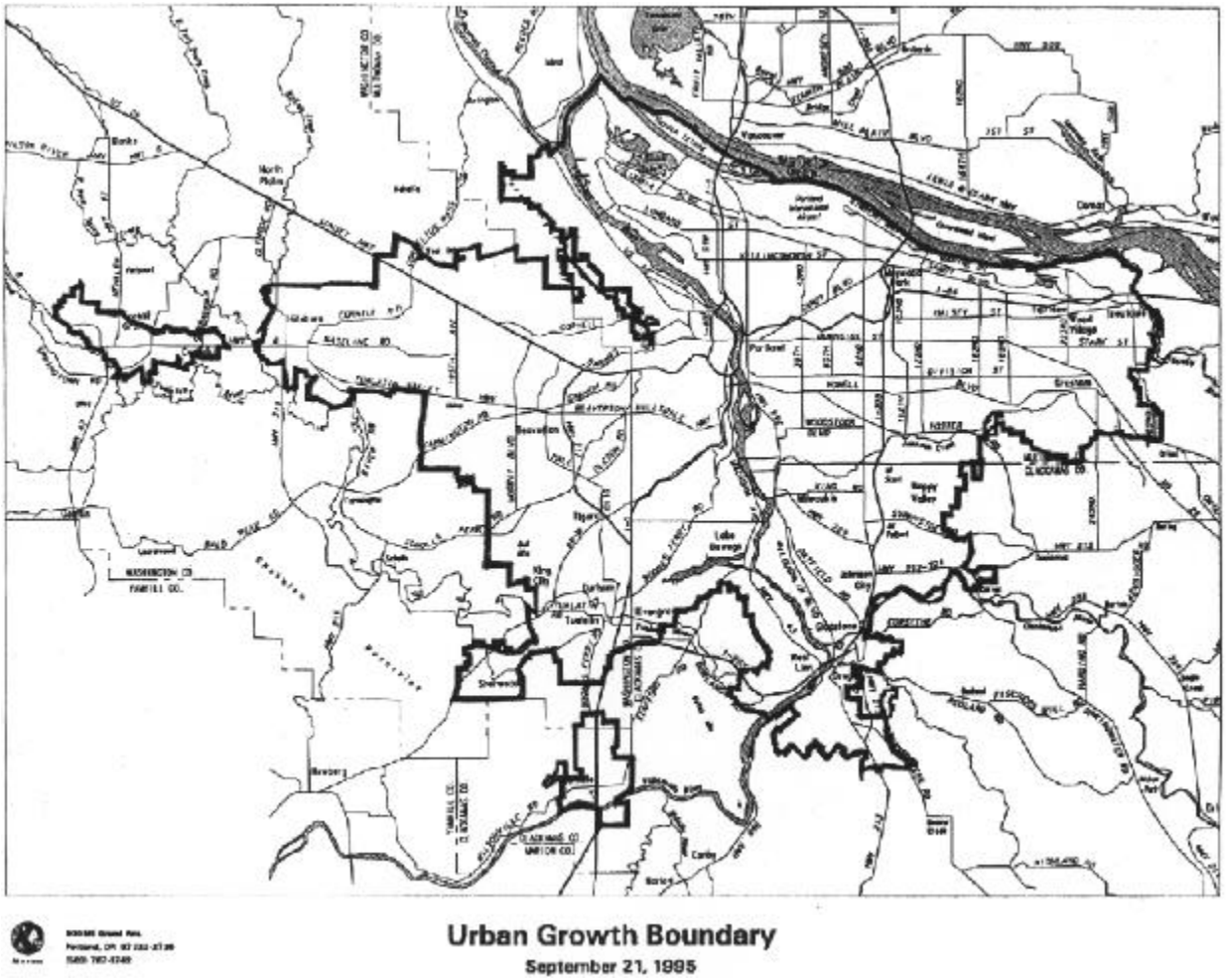
PORTLAND METRO

Portland Metro is the only directly elected regional government in the U.S. and serves more than 1.3 million residents in Clackamas, Multnomah and Washington Counties and the 24 cities in the Portland, Oregon, metropolitan area. Metro provides a range of services that cross traditional boundaries between cities and counties. Metro's primary mission is to manage growth in this region; transportation and land-use planning are key elements in managing that growth. Along with its primary mission, Metro oversees a variety of services ranging from regional solid waste recycling and disposal to operation of the Washington Park Zoo, a park system and several convention and civic centers.



For more information visit the Metro homepage: http://www.multnomah.lib.or.us/metro/index.html

Figure 2: Map showing City, County and Metro boundaries of the Portland area.

Region 2040 Framework Plan

Currently Metro is developing guidelines for the Region 2040 growth management program which will help its communities accommodate more people and enhance livability over the next 50 years. This concept was adopted in 1994 after extensive public input and unanimous approval of several regional advisory bodies. A 2040 Framework Plan has been drafted and specifies how the region and local communities will implement the Region 2040 growth concept. The draft plan is now undergoing a public review and input process. The final plan is scheduled for Metro Council adoption in December, 1997.

Metro is using an integrated process to consider many strategies for accommodating growth including subdividing large lots, redevelopment in older built-up areas, improved transit service, increasing protection of fragile soils and steep slopes, preserving riparian corridors, preserving natural areas and protecting the region's watersheds to minimize impacts on water quality and quantity, and various natural resources.

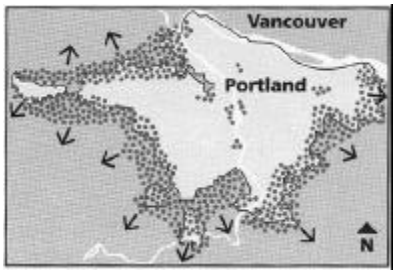
If growth continues at present rates, the UGB will need to be extended. The plan calls for about 14,000 acres of "urban reserves" located in the southeast portion of the region just outside the present UGB to be designated for future development.

URBAN GROWTH

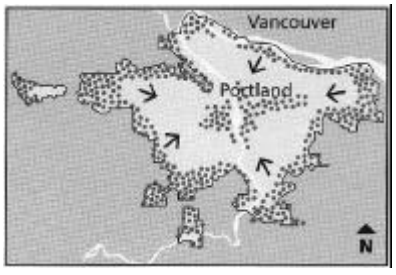
Growth management is Metro's top priority. Metro coordinates growth management through regional transportation and land use planning and through its state given authorities (Senate Bill 100) for establishing and maintaining an urban growth boundary (UGB) for the Portland Region (Figure 3). Areas outside the UGB are designated rural reserves to preserve farm land, forestland and natural areas. Inside the UGB, great care is taken (e.g. infilling and reuse of existing development) to preserve as much open space as possible.

STORMWATER MANAGEMENT

Stormwater management infrastructure is managed by individual cities or the Unified Sewerage Agency (principally Washington County). Metro works with its constituents to set broad policy on planning stormwater controls, especially as they relate to the protection of the region's natural resources. Metro will soon develop regional stormwater management standards to be incorporated into local, municipal codes. Until these standards become a reality, each community has a different level of sophistication or focus in stormwater management. This creates inconsistencies as discussed further in the individual community visits. Metro's new standards may emphasize daylighting of sewers wherever appropriate and mandatory riparian buffers along all open streams.



Case A: Growing Out



Case B: Growing Up

Case C: Satellite Cities

Figure 3: Possible growth scenarios from the Region 2040 Framework Plan (Metro, 1994) for the Portland Metro area. A modification of Case B was the final recommendation.

Metro for the second year is sponsoring a stormwater management design competition as a part of its public information program. The purpose of the contest is to stimulate public interest and encourage innovative design approaches through interdisciplinary alliances. Respondents are professionals from local firms and jurisdictions. Metro provides a handbook of the design entries (15 in 1996) and showcases the competition winner.

Other Metro sponsored stormwater management initiatives include citizen storm drain stenciling (warning against dumping toxics), citizen tree planting for riparian buffers, hazardous household waste disposal program, and advancing geospatial coverage of sensitive areas and data needed to perform stormwater management analyses.

Oregon Museum of Science and Industry parking lot, City of Portland.

Clackamas County wet pond/constructed wetland in shopping area.

Riparian vegetation along Fanno Creek.

Jackson Bottom Wetlands Peserve.

Figure 4: Portland Metro stormwater management strategy sites.

STORMWATER MANAGEMENT STRATEGIES

The group visited three areas: City of Portland, Clackamas County and Washington County (Unified Sewerage Agency). Each is faced with increasing development within the UGB. The City of Portland, the most heavily developed of the three, focuses on retrofitting and rehabilitation of existing development and the restoration of remaining streams and corridors. Clackamas County is the most rapidly developing area in Metro and is striving to gain more control of its stormwater management activities through improving its efficiency of operations and an advanced baseline water quality monitoring program. The Unified Sewerage Agency has an integrated point, non-point source strategy which provides extensive watershed planning with aggressive public involvement.

CITY OF PORTLAND

The City of Portland like several other Metro communities has had a stormwater utility since 1977. All developed property is subject to a user fee of about $0.02 per square foot of impervious surface. The rate structure is under revision to recognize features such as credits for good stewardship, use of effective best management practices, and the degree to which runoff is handled on-site through infiltration or re-use. The collected fees are used for maintaining and retrofitting minor stormwater management infrastructure.

Portland has initiated the use of vegetated swales or “bio-swales” in parking lots to reduce both pollutant loads and runoff. Rather than

Figure 5. Vegetated swales or "bio-swales' in the parking lot of the Oregon Museum of Science and Industry. Bio-swales filter pollutants and infiltrate runoff and can be a less expensive approach to parking lot drainage.

landscaping between rows of parking, a swale or graded depression is constructed and planted with native wetland plants such as cattails, and bulrushes. These linear retention basins are designed to slowly pass and pretreat runoff along a gentle incline. A raised drain inlet is located in the lowest point of the swale and will not pass flow below the design storage level. The receiving catch basin has a capacity for storing several years of sediment accumulation.

At the Oregon Museum of Science and Industry an 800 space parking lot has been designed as a demonstration project for use of bio-swales. The parking lot is located adjacent to the Willamette River. Conventional parking lot drainage would have piped flow directly into the river. The parking lot was designed to incorporate seven bioswales. Each parking stall was shortened by 2 feet to 16.5 feet for a full-sized car. The saved space was applied to widening the swales.

The bioswales as installed will infiltrate 0.83 inches of rainfall over 24 hours - about 75 percent of Portland's rain events annually. The city's Bureau of Environmental Services (BES) is monitoring the

Figure 6. A recently established bio-swale in the OMSI parking lot. Vegetation has just been planted. Note that runoff can freely enter the swale through the curbing.

Figure 7. Looking in the direction of flow along a bio-swale. Where slopes exceed 4 percent, check dams as seen in the foreground are installed at intervals not exceeding 50 feet.

effectiveness of these swales and expects they will achieve up to 90 percent reduction in suspended solids from lot runoff. BES is also comparing the effectiveness of a general purpose seed mix recommended by researchers (Horner, 1988) to a mix comprised solely of native species.

Surprisingly, the OMSI parking-lot construction costs were $78,000 less than those of a conventional lot design. This reduced cost is clearly beneficial, but with any stormwater management measure, significant maintenance may be required.

Another innovation is the use of green roofs, or eco-roofs installed in downtown Portland for esthetics and stormwater management. Many of these can be viewed from parking garages several floors above street level. Viewers can see well-groomed lawns, trees and shrubs atop an assortment of buildings (Figure 8). A lightweight, organic medium with added nutrients supports plant growth. The vegetation and media may retain up to 0.5 inches of rain. More research is needed on effectiveness and efficiencies of this Belgian-originated concept. The Portland Bureau of Environmental Services is developing a design guide for eco-roofs and encouraging their use on both industrial and commercial buildings.

Figure 8. Green or eco-roofs are popular in downtown Portland and retain much of the initial rainfall.

On the north side of Portland is the Columbia Slough which drains the deltaic area between the confluence of the Willamette and Columbia Rivers. The lower portions of the slough are tidal and have afforded navigation and port opportunities. This area has a long history of industrial use resulting in channelization (straightening and deepening) and a discharge/disposal area for a variety of industrial wastes. There have been attempts to restore the slough since the 1970's, however, eutrophication continues to be a problem along with low dissolved oxygen levels. There are also low levels of several toxic materials (associated with the sediments) which potentially threaten fish consumption, but not water quality per se. The Bureau of Environmental Services has established three main goals for the Columbia Slough Watershed: 1) consumable fish and swimmable waters; 2) restoration of native habitat in the form of wetland meadows, and 3) restoration of the forested riparian zone. To achieve these, BES in conjunction with a variety of local, state and federal partners, are restoring wetland meadows, ambitiously reforesting the riparian zone, and pursuing a variety of strategies for reducing the levels of sediment, nutrient and glycol influxes from nonpoint sources.

Figure 9. View of restoration work along the Columbia Slough riparian zone in Portland's International Raceway Park. Includes tree plantings (left), vegetation establishment at culvert outlet for filtering sediments(center), and wetland enhancement and plantings (center and to right).

Figure 10. Riparian zone tree plantings along an upper reach of the Columbia Slough. The socks around trees protect them from nutria and beaver. Red alder and Oregon ash will shade out invasive Himalayan blackberry and reed canary grass.

Wetland meadows are restored wherever opportunities become available such as at the City-owned International Raceway Park (Figure 9).

BES also provides a cost share program to landowners for planting and maintaining (5 year period) trees. BES oversees the planting which frequently involves "Workers for the Environment", a state sponsored program.

The City of Portland also has a vigorous program to separate combined sewer outfalls (CSO's). CSO's are common in older cities where early engineering promoted the use of a single pipe to collect and transport both sanitary and storm sewage. The strategy used in Portland is to contain up to medium size (0.83 inches) rainfall-runoff events for 48 hour detention and to bypass larger flood flows at strategic intervals. Figure 11 shows a detention basin (one of three in series) at a storm sewer outfall. After passing through the settling/ infiltration basins over a 48 hour period, the flow passes through a jurisdictional wetland which drains into the slough. Those who oppose the extremely expensive separation approach advocate the treatment of the more frequent flow events through increased waste water treatment plant capacity and allowing a few overflows per year.

Other efforts to improve the quality of storm runoff in the Slough watershed include increased attention to erosion and sediment control, practices for the reduction of glycol in runoff from nearby Portland International Airport, and removal of sediment and nutrients by improving the quality and quantity of vegetation in riparian zones.

Figure 11. A large stormwater detention complex near Ramsey Lake Wetland. Stormwater discharges from sewer (right) pass in 48 hours through 3 storage components (center and to left and background) before release to a wetland and outlet to Columbia Slough.

CLACKAMAS COUNTY

Clackamas County, which forms the southeastern portion of the Metro Region, is experiencing extremely rapid growth in its urbanized sector. Its Engineering, Surface Water and Technical Services Division formed in 1992 and has responsibility for stormwater management in the urbanized area encompassed in its service district. The Division is currently developing rules and regulations for surface developments and has adopted the King County, Washington program (Dr. Richard Horner, University of Washington) for hydrologic analyses.

The Division has laid a solid foundation in transitioning from manual to computerized operations in the past five years. The keystone is the development of the application "MoClack", which uses ESRI™ MapObjects and Microsoft™ Visual Basic to bring together a wide array of GIS data into an easy to use interface. Examples of digital data include 127,000 parcel lots, rivers, wetlands, flood zones, building permits, zoning, soils, service district boundaries, topography (10ft./2ft. contours), over 3000 tax map images, sanitary sewer customer data, sanitary and storm sewer system with "as built" images, and digital ortho photography at three resolutions. The system runs on a variety of hardware ranging from 486/66 to Pentium Pro's™ running Windows NT™. All data is available via a 10 base T switched network as well as over the Internet.

More information about this system and Clackamas County in general is available on their world wide web site at http:// www.co.Clackamas.or.us/

The use of MoClack is expanding rapidly and includes administering daily customer service, complaint tracking, and planning and research. A terminal for walk-in use by developers and others is available at the Division's front service counter. This allows users to perform their own queries and frees the small staff to focus on high priority concerns. Time required to compile GIS and other data has been drastically reduced. The development cost for this system exclusive of available commercial software was about $40,000 and took approximately one year to develop. This system is extremely advanced and user-friendly and is receiving accolades from other potential users throughout Oregon and the West Coast.

Figure 12: A piped system through an industrial park has been opened (daylighted) to decelerate and process flow by vegetation and infiltration, and to regain some riparian

As the county increases its involvement in stormwater management, it is encouraging a variety of best management practices. One seen in figure 12 is to "daylight" closed piped storm sewers to provide for natural filtration and reduction of flow velocities as well as restoring riparian function. Additionally,

wet ponds with shoreline wetland plantings are often used in the final stage (polish) of stormwater treatment (figure 13).

Figure 13. A newly established wet pond/ constructed wetland at the outlet of a shopping area parking lot in Clackamas County. Sediment is trapped upstream of the wetland. Infiltration moves to the stream (hidden in background). Overflow occurs only during large events.

UNIFIED SEWERAGE AGENCY (TUALATIN RIVER BASIN)

The Unified Sewerage Agency (USA) provides sanitary and surface water management services within the urbanized portion of the Tualatin River Basin primarily within Washington County, Oregon (located south and west of Portland). USA maintains storm sewers and natural drainage systems, develops and enforces regulations, implements public awareness programs, coordinates volunteer projects, monitors streams, and builds flood control and water quality facilities.

The Oregon Department of Environmental Quality has imposed strict water quality requirements (0.07 mg/l phosphorus standard for summer-time effluent) for the Tualatin Basin to restore and protect the river from eutrophication in the lower reaches. In response USA has constructed and operates state-of-the-art sanitary wastewater treatment facilities that achieve beyond-tertiary levels of pollutant reduction. For example, effluent concentrations of phosphorus from the Durham Wastewater Treatment Facility (WTF) contains less than 0.07 mg/l of phosphorus and virtually no ammonia nitrogen during the critical water quality months of May through October. The Durham WTF is one of the most advanced wastewater treatment facilities in the world.

A major challenge for USA in its role as the surface water management utility for urban Washington County is to achieve a TMDL (Total Maximum Daily Load) reduction target of 65 percent of the phosphorus load from an average annual summer storm in the lower reaches of the Tualatin River. Because advanced techniques for removal of phosphorus at its waste water treatment plants are already in place, USA is attempting further load reductions from nonpoint sources. They are undertaking a vigorous initiative to address the management of nonpoint runoff sources. The initiative centers around a citizen/ community participation process to develop watershed plans for priority tributaries.

USA has completed its first comprehensive watershed management plan for the Fanno Creek tributary. The plan details existing watershed conditions and problems that could arise with future development. The plan recommends actions to address key issues of flooding (undersized culverts, channel modifications, and floodplain encroachment); water quality problems (elevated stream temperature, pollutants such as heavy metals, oil, fertilizers, pesticides, and bacteria); degradation of fish habitat (siltation, lack of woody debris and shade) and loss of wildlife habitat (loss of riparian vegetation and invasion of non-native species). The Fanno Creek Management Plan recommends four categories of management actions (Table 1).

USA is a stormwater management utility and raises funds to carry out

Table 1: Fanno Creek management plan actions.

Category	**# of Sites**	**Action**
Structural Water Quality, Flood Prevention	32 Projects	Increased storage of floodwater in floodplains, Wetland enhancement Streambank restoration, Installation of small stormwater treatment systems
Structural	74 Projects	Bridge and culvert replacement
Non-Structural	12 Projects and Programs	Protect remaining natural areas Improved maintenance practices Centralized citizen response Identification of bacteria and metal sources On-site stormwater detention Better land use enforcement, water conservation and erosion control
Community-based	32 Sites	Planting and streambank restoration

Figure 14. A stormwater extended-detention basin for an apartment complex in the Fanno Creek Watershed. Runoff from normal, summer rainfall events is temporarily stored and cleansed by slow passage through the underlying materials of the basin. Portions of larger events overflow to stream.

stormwater management programs like the Fanno Watershed Project through collection of fees based on the amount of impervious surface on each property. Single family homes pay a flat fee of $3 per month while other property owners (no exceptions) pay based on their measured impervious area from aerial photographs.

USA seeks to reduce runoff, increase infiltration and provide treatment of runoff on-site using such techniques as minimizing paved areas, bio-swales for parking lots, vegetated buffers of native species, and constructed wetlands. Installation of small, stormwater treatment systems (such as in Figure 14) provide the first opportunity for reducing and processing runoff as it leaves the site. Bio-swales and constructed wetlands are also popular.

Restoration of native species along the riparian zone is an important management action. Figures 15 and 16 show contrasts in riparian vegetation on either side of an Upper Fanno Creek crossing.

Figure 15. One of the planned management actions for Fanno Creek is to restore and protect riparian vegetation such as seen here along upper Fanno Creek. Compare this to the lack of riparian cover seen just downstream in Figure 16.

Figure 16. A view of Upper Fanno Creek looking just downstream of Figure 15. This reach of stream has been channelized through a golf course and has lost nearly all of its

Streambank restoration is an integral part of the management plan. Soil bioengineering techniques (Figure 17) are applied wherever possible to restore banks to conditions such as in Figure 18. This is a continuing challenge as imperviousness increases in the watershed.

Figure 17. Native species are just beginning to grow in this early spring view of a vegetated geogrid treatment of a streambank along Upper Fanno Creek. The installation was made by youth corps volunteers.

To provide more floodplain storage, USA removes impervious areas where opportunities arise and excavates these areas for conversion to wetlands with provision for more flood storage. One project on the Woods Creek Tributary calls for excavating a floodplain soccer field one foot to provide additional flood storage, and another to move an instream pond to an off-stream location where it can provide temporary flood storage, while the creek is freed for normal and flood flow functions.

Another of USA's initiatives is a public education outreach program to both children and adults. The River Rangers Program is designed for use by environmental educators to inform the public about how they impact water quality through their use of sewer and storm systems. Although originally designed for the Tualatin Basin, the program is very popular and is now available in a generic version. The program includes 16 full-color posters which aid in telling the story of water as it travels through homes and on to the treatment facility and finally into the rivers and streams. An activity package and a 30-minute training video are also included.

Figure 18. A mix of native and other species protect this reach of Upper Fanno Creek just downstream of the site shown in Figure 17.

USA also distributes

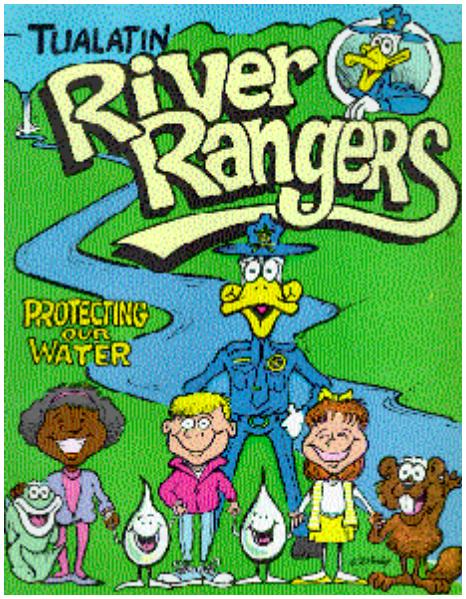


Figure 19: Tualatin River Rangers Program Cartoon Cover from http://www.usa-cleanwater.org/morangr.htm

For more information contact USA's Public Involvement Division at : mjockers@usa-cleanwater.org

"Stream and Wetland Enhancement Guide", a foldout pamphlet with lots of information on native plants, schematics for riparian zone plantings and enhancement, plant management, and warnings about invasive, non-native species.

UNIFIED SEWERAGE AGENCY (JACKSON BOTTOM WETLANDS PRESERVE)

Figure 20. View of Kingfisher Marsh from a public observation pavillion installed at the Jackson Bottom Wetland.

Jackson Bottom is a 450 acre, mostly wetland preserve situated in the broad Tualatin River floodplain within the City of Hillsboro, Oregon. The preserve is managed by a steering committee comprised of representatives from eleven agencies, organizations and cities, including Hillsboro and Portland, for preserving and enhancing habitat diversity, water quality, education research and passive recreation. Jackson Bottom was at one time drained and farmed, later received cannery waste and construction debris, and since the 1970's has been progressively restored to what is now a premier resource center for information and services related to wetlands and aquatic education in the metro region.

The 1989 Jackson Bottom Concept Master Plan outlines four main goals of the wetlands preserve

1. Enhancement for wildlife by expanding and restoring the wetlands to attract a more diverse wildlife population.
2. Water quality management by developing the Jackson Bottom Experimental Wetland. Investigate the feasibility of using wetlands to remove additional phosphorus and nitrogen from the effluent of a secondary wastewater treatment plant.
3. Passive recreation by providing access to areas of the wetland and the Tualatin River for public enjoyment without threat to its natural features.
4. Education and research promotion through interpretive signage and displays, development of educational materials, site tours, and assistance to research projects.

The wetlands are naturally replenished with inflows from the Tualatin River during regular flooding. A 15 acre experimental wetland receives additional inflow from USA's Hillsboro Wastewater Treatment Plant during drier, summer months. The experimental wetland is part of USA's comprehensive effort to reduce phosphorus and nitrogen loading to the water-quality limited Tualatin River. A variety of trial conditions have been examined within the 17 parallel cells of this wetland. Three years of monitoring provide an initial indication of the

wetland's effectiveness. The three year average concentrations of various forms of nitrogen have been reduced by more than 59 percent while the average concentrations of total phosphorus are down about 39 percent. Long-term monitoring will be needed especially to evaluate the behavior of phosphorus and a number of other parameters which can accumulate, transform, scour, and be released

SUMMARY

Portland Metro is unique in many ways - from its regional government status to its urban growth management. Initiatives to preserve and protect adjoining rural areas while reducing the impact of urban densification within the carefully-planned urban growth boundary are quite different from those of other urban growth areas across the country.

Metro is increasing its emphasis on stormwater management. Performance standards are being drafted by Metro communities; and a stormwater management design competition is stimulating professionals to emphasize innovative stormwater considerations.

Metro local governments are taking diverse stormwater management actions. Portland and USA administer stormwater utilities to support both maintenance and new projects. They are emphasizing a variety of practices ranging from on-site infiltration to bio-swales, and restoration of the riparian corridor. Portland is promoting green roofs in the dense downtown core. USA has a strong program in phosphorus and other pollutant load reduction.

Clackamas County is experiencing the most rapid growth in the region. Its focus has been on developing a new operational structure, for example the computerized MoClack, to be more efficient in servicing growth demands. The County is focusing on monitoring for baseline stormwater conditions, strengthening of stormwater requirements, and the thoughtful application of advanced BMPs.

Jackson Bottom exemplifies the value the region holds for its precious natural resources. This unique wetland which has management oversight from eleven of the region's influential entities provides multiple uses from wildlife refuge to public education and research.

Much can be learned from the activities of the Portland Metro region. Metro's progress as seen on its home page and publications will be of continuing interest to those involved in urban natural resource issues.

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